TREE DISEASE IN FLORIDA LANDSCAPES: CONCEPTS & CATALOG[1]

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by

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Introduction

Understanding tree disease is rarely a simple task, even for the highly trained specialist. Not only are many of the causes of tree disease particularly elusive, tree diseases are more often than not, the consequences of a variety of influences acting in synergism or succession. The impacts of tree disease range from subtle (e.g., no visible evidence of symptoms, perhaps only a slight reduction in growth) to dramatic (e.g., highly visible growth aberrations or death of tree parts or entire trees) depending upon host species, associated environmental/cultural conditions, and specific causal agents involved.

Tree disease may be defined as the **sustained or progressive impairment of the structure or function of a living tree.** Tree disease is a process involving time, as opposed to tree injury which is damage inflicted by a passing agent or event. Often, tree disease is associated with tree injury, but the two are distinct. Understanding the distinction facilitates correct interpretation and diagnosis. Insect damage to tree is often referred to as injury, and as such is again distinct from disease per se. As with other injuries, however, it is not at all uncommon to find tree disease associated with insect injury. Sometimes injury (insect or other) predisposes trees to disease infections, and sometimes the presence of disease weakens a tree to the point where is becomes vulnerable to injury by insects or other agents. Such associations and/or interactions are common and the subtleties and variations of same are legion.

Tree diseases are caused by a variety of factors often referred to generally as **causal agents**. Causal agents may be living (**biotic**) or non-living (**abiotic**). Biotic causal agents are called **pathogens** (i.e., disease-producing organisms) and are not synonymous with disease; i.e., **pathogens are not diseases, pathogens cause disease.** Table 1 provides a brief listing of some common causal agents of tree diseases.

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[1] A partial treatise of important and interesting tree disease in Florida landscapes.

TABLE 1. Some common causes of tree disease.

Non-Living (Abiotic) Causal Agents	Living (Biotic) Causal Agents: Pathogens
Temperature Extremes Moisture Extremes	**Fungi*:** Lower plants with thread-like (filamentous) vegetative stages (threads collectively called hyphae: sing., hypha). Typically reproduce via spores produced in or on various structures called fruiting bodies. Fruiting bodies range from microscopic to large (mushrooms, etc.) depending upon the particular fungi involved.
Soil Compaction	**Bacteria:** Microscopic, single-celled plants with cell walls. Reproduce by fission (splitting) or budding.
Nutrient (Fertilizer) Deficiencies	**Viruses:** Sub-microscopic particles consisting of specific nucleic acid molecules covered with protein coats.
	Seed Plants: Higher plants that reproduce by seed.
Chemical Injuries (herbicides, excess fertilizers, etc.)	**Mycoplasmas and/or Mycoplasma-like Organisms (MLO):** Submicroscopic organisms more complex (advanced) than viruses, but less complex (lower) than bacteria. Mycoplasmas have no cell walls. Reproduce by budding or fission, and are typically found in the phloem of host plants or trees.
Air Pollutants	**Nematodes:** Minute to microscopic worms.

* Fungi currently constitute the largest and most thoroughly studies group of tree pathogens.

Four elements are essential in order for tree disease to occur. These are 1) a susceptible host tree, 2) a pathogen (or other causal agent), 3) environmental conditions conducive to disease development, and 4) sufficient time for disease to develop. Perhaps surprisingly to some, it is the norm for many susceptible host trees to "peacefully co-exist" with pathogens for years without becoming diseased. This is possible as the associated environmental conditions are not conducive to disease development or the trees are not predisposed (via injury, etc.) to infection by the pathogens involved. Understanding the interrelationships among the essential elements for disease occurrence is vital to understanding why certain diseases occur and how they might be avoided. Any alteration in the environmental conditions associated with trees, whether natural or man-generated, can and often does, predispose trees to infection by one or more disease-causing organism(s).

Types of Tree Diseases

There are many ways to characterize tree diseases. Often, diseases are classified or described on the basis of the tree part affected and/or types of symptoms produced. Table 2 provides a synoptic overview of some common disease types using such a classification scheme.

TABLE 2. Some common diseases of Florida trees.

Symptom/Description	Common Hosts	Possible Causes	Comments
		FOLIAGE	
Algal Leaf Spot (Green Scurf"): RAISED greenish brown to rusty spots	**Magnolias:** *Magnolia* spp. **Live oak:** *Quercus virginiana* **Avocado:** *Persea americana* **Other "leathery" leafed trees**	**An alga:** *Cephaleuros virescens*	*Cephaleuros* sometimes forms lichens with certain fungi. These lichens (*Strigula* spp.) appear as green to white crusts with black spots on leaves.
Anthracnose: large, irregular BLOTCHES of necrotic (dead) tissue, often along or delimited by veins in leaf tissue.	**Acacia:** *Acacia spp.*	**Fungus:** *Glomerella cingulata* (Asexual stage: *Colletrichum gloeosporioides*)	Severe infections often progress into twig infections resulting in branch dieback.
	White oak: *Quercus alba* **Other oaks:** *Quercus* spp.	**Fungus:** *Gnomonia quercina* (Asexual stage: *Gloeosporium quercinum*)	
	Sycamore: *Platanus occidentalis*	**Fungus:** *Gnomonia platani* (Asexual stage: *Discula platani*)	
	Elms: *Ulmus* spp.	**Fungus:** *Gnomonia ulmea* (Asexual stage: *Gloeosporium ulmeum*)	
Blight: RAPID DISCOLORATION AND DEATH OF FOLIAGE, often most serious on younger foliage at branch tips	**Pears:** *Pyrus spp.* **Loquat:** *Eriobotrya japonica*	**Bacterium:** *Erwinia amylovora*	**Fire blight.** Infections typically progress into twigs and branches.
	Various hardwoods	Unseasonal frost or chemical damage, certain fungi.	
Blister: irregular, raised of wrinkled BLISTERS on otherwise green foliage	**Oaks:** *Quercus* spp.	**Fungus:** *Taphrina caerulescens*	**Oak leaf blister**
	Peach: *Prunus persica*	**Fungus:** *Taphrina deformans*	**Peach leaf curl**

Chlorosis: general or interveinal YELLOWING of foliage tissue	**Oaks:** *Quercus* spp. **Pines:** *Pinus* spp. **Other Trees**	Nutritional imbalance or deficiency often related to soil conditions (esp. high soil pH), root disease (including nematode infections), certain types of herbicide damage, vascular dysfunction, etc.	
Leaf Spots: discrete circular to irregular, variably colored SPOTS on otherwise green leaves	**Various hardwoods**	Miscellaneous fungi. Some bacteria.	
Marginal Leaf Scorch or Necrosis: narrow to wide BANDS or patches of dry (papery), brown, dead leaf tissue at tips or margins of leaves	**Various hardwoods**	Drought, root disease, vascular dysfunction (fungal or bacterial vascular wilts), salt water intrusion, excess fertilizer, etc. Certain types of air pollution, chemical injuries, viruses.	Basically indicative of lack of water to the leaves.
Mottling, flecking varigation or Ring Spots: discrete PATTERNS of tissue yellowing in otherwise green leaves	**Various hardwoods**	Certain types of air pollution, chemical injuries, viruses.	
Needle Cast: distinct REDDENING/ BROWNING of NEEDLES, from needle tips inward, typically on older needles and often seasonal	**Pines:** *Pinus* spp.	**Fungi:** *Lophodermium* spp. and others	
Powdery Mildew: WHITE, POWDERY TO CHALKY OR MEALY FUNGUS GROWTH on the surface of green and sometimes slightly shriveled, distorted or malformed leaves	**Elms:** *Ulmus spp.* **Crape myrtle:** *Lagerstroemeria speciosa* **Various hardwoods**	**Fungi:** *Uncinula macrospora, Erysiphe lagerstroemiae*, and others	

Rust: occurrence of bright YELLOW-ORANGE PUSTULES, COLUMNS or POWDER on leaves	**Various hardwoods**	Various fungi which produce yellow-orange pigmented spores in pustules or columns.	
	Pines: *Pinus* spp.	*Coleosporium* spp.	
Sooty Mold: DARK MEALY OR SPONGY TO SOMEWHAT CRUSTY FUNGUS GROWTH on leaves (and sometimes stems)	**Various hardwoods** **Pines:** *Pinus* spp.	Various dark-pigmented fungi	Sooty mold fungi are not parasitic. They feed on and are generally associated with natural or insect (aphids, scales, etc.) created exudates. When abundant, may reduce photosynthetic activity of leaves.
Tar Spots: HARD, BLACK, RAISED, TAR-LIKE or CRUSTY FUNGUS GROWTHS on the upper surface of infected leaves	**Mahogany:** *Swietenia mahogani*	**Fungus:** *Phyllachora swieteniae*	
	Yellow Poplar: *Liriodendron tulipifera* **Elms:** *Ulmus* spp. **Maples:** *Acer* spp. **Various hardwoods**	**Fungi:** *Rhytisma* spp. including *R. acerinum* (maples)	
Wilt: a DROOPING and FLACID (limp) APPEARANCE OF LEAVES, may be accompanied by degrees of chlorosis and marginal scorch or necrosis (above)	**Various hardwoods**	Drought, root rot, vascular infection and/or dysfunction. (See marginal Leaf Scorch - above)	Indicative of a lack of water to the foliage.
	Pines: *Pinus* spp.	Possibly **pine wood nematode** (*Bursaphelenchus zylophilus*) in pines.	

BRANCH, STEM & ROOT

Canker: Progressive NECROSIS OF CAMBIAL AND BARK TISSUES in twigs, branches, or stems resulting in branch dieback, FLATTENED AREAS ALONG OTHERWISE ROUNDED STEMS, decortication and/or development of CALLUS tissues at margins of necrosis	**Mahogany:** *Swietenia mahogani* **Maples:** *Acer* spp. **Oaks:** *Quercus* spp.	**Fungus:** *Nectria galligena*	Often stress and/or injury related
	Various trees	Various fungi. Occasionally bacteria	
Gall distinct smooth or irregular SWELLING or HYPERTROPHY of wood tissues at various points on stems/ branches	**Red Mangrove:** *Rhizophora mangle*	**Fungus:** *Cylindrocarpon didymum*	
	Bottlebrush: *Callistemon* spp. **Citrus:** *Citrus* spp. **Dahoon Holly:** *Ilex cassine* **Brazilian Pepper:** *Schinus terebinthifolius*	**Fungus:** *Sphaeropsis tumefaciens*	
Heart Rot DECAY/ DETERIORATION of wood tissues in CENTRAL CORE (heart, heartwood) of stems/branches	**Most trees**	Various basidiomycetous fungi	Often injury related and common in mature/ over-mature trees
Witches Broom pronounced PROLIFERATION OF SMALL TWIGS/ BRANCHES resulting in ROSETTE- or BUSH-LIKE BUNCHES of small stems; may appear also as proliferation of epicormic shoots along stems	**Various trees**	Various organisms including mycoplasma like organisms **(MLO)**	
Root/Butt Rot NECROSIS AND/OR DECAY OF ROOTS and tree bases	**Various trees**	Various fungi	Butt rots common on mature/overmature trees, esp. where basal injury is involved

Localized vs. Systemic Infections

Some tree disease infections are localized while others re systemic in nature. Localized infections are those in which the pathogens are confined predominantly, of not completely, to the specific tissues and/or tree parts expressing symptoms. Leaf spots, galls, cankers, and blights are typical of localized infections. Systemic infections, on the other hand, are those in which the pathogens involved are systematically distributed throughout much or all of the host tree's vascular system (xylem and/or phloem) despite the fact that symptom expression may be confined to certain tissues or tree parts. Examples of systemic infections would include fungal vascular wilt diseases such as Dutch elm disease, oak wilt, mimosa wilt, and persimmon wilt. Other examples of systemic disease infection include diseases of mycoplasma-like organism (MLO) etiology such as lethal yellowing of palms and leaf scorch diseases caused by xylem-inhabiting bacteria.

Disease & Trees/Natives & Exotics

Many tree diseases are the result of interactions between **indigenous pathogens and native tree species.** Interrelationships between such pairs of organisms have often, through the course of time, acquired a certain degree of stability; i.e., a delicately balanced "peaceful coexistence". Accordingly, diseases resulting from their interaction rarely pose a serious threat to the perpetuation of a host tree species, and many result in only limited or ephemeral blemishes to otherwise vigorous trees. Indeed, many of the "problem" diseases resulting from the interaction of such pathogen-host pairs develop only in response to natural or artificial interruptions in the immediate conditions upon which stability is dependent. For example, the incidence of and damage caused by fusiform rust, an indigenous fungal disease of southern pines has, since the mid 1930's been on a steady incline to the point where it is now the most damaging and economically important disease impacting forestry in the southern United States. In large measure, the rise of this heretofore low impact indigenous disease to its now epidemic proportions is directly related to 1) the extensive establishment of highly susceptible pines in vast plantation "monocultures" across the south and 2) the simultaneous improvement in forest fire control which has resulted in increased populations of oak species, necessary alternate hosts in the life cycle/ reproduction of the pathogen.

Other diseases are caused by the **natural encroachment or inadvertent introduction of exotic (i.e., foreign) pathogens** into ecosystems supporting susceptible host tree species. All too often tree diseases resulting from this type of host-pathogen juxtaposition are devastating due to 1) the lack of innate genetic resistance to the introduced pathogen within the tree population invaded and/or 2) the lack of other biological controls oftentimes active in the ecosystem where the pathogen is endemic. One needs only to reflect upon the aftermaths of chestnut blight, Dutch elm disease, and lethal yellowing of palms in the United States to appreciate the magnitude of threat represented by diseases of this genre.

A third important group of tree diseases is that in which **exotic tree species are introduced into environments supporting indigenous pathogens against which the introduced trees have no innate resistance**. Pathogen-host interrelationships within this group are analogous in many ways to those of the preceding group except that the introduced organism is the tree, not the pathogen. The destruction of Formosan sweetgum (*Liquidambar formosana*) introduced into southern Mississippi by the native canker fungus, *Endothia gyrosa*, is an example of this type of disease situation.

Potpourri of Some Noteworthy Diseases of Trees in Florida Landscapes

Pitch Canker

Pitch canker is an indigenous fungal disease of pines. The pathogen, *Fusarium subglutinans*, can and does infect all southern pines to greater or lesser degrees. It is capable of causing damage to susceptible pines at any point in their life cycles. For example, the pathogen can infect and destroy pine flowers (i.e., conelets), cones, seed, seedlings, and roots, as well as branches and stems of mature trees. Typical infections on mature branch and stem tissues result in the death of terminal branch/ stem shoots ("flagging") and the production of copious quantities of resin (pitch) by the infected tissues. Resin may "bleed" from infected tissues producing easily recognizable symptoms, and infected wood tissues are characteristically resin-soaked.

Pitch canker infections are initiated by microscopic spores of the pathogen which are disseminated aerially and/or by the eastern pine weevil (*Pissodes nemorensis*) which is a known insect vector of the pathogen. The fungus is a wound pathogen and apparently does not infect intact pine tissues. Thus, it is common to find pitch canker infections associated with various injuries (insect or other) on branches and stems. Injuries sufficient for infection to occur need not be very large as spores of the pathogen are only a few micrometers in size.

Pitch canker infections are often much more serious and damaging on pines exposed to luxuriant levels or imbalances of certain mineral nutrients such as nitrogen. Accordingly, infections are often more problematic on pines growing in intensively managed landscape situations such as golf courses, housing developments, etc.

Pine Chlorosis

Pine chlorosis (yellowing) and decline is one of the most serious problems affecting pines in areas of Florida (esp. south and central Florida) which have become or are becoming heavily "urbanized". The gradual and oftentimes pronounced yellowing of pines in intensively managed landscapes such as golf courses is symptomatic of micronutrient deficiency (esp. iron and manganese) induced largely by rising soil pH levels (i.e., a shift from acid to alkaline soil) caused by the high levels of dissolved limestone typically present in irrigation water from Florida's undergound aquifer. Although certain remedial prescriptions (soil amendments, foliar sprays, etc.) may be useful, effectively dealing with this problem will require substantial modifications in

landscape design philosophy. Healthy pines and rich green turf are not necessarily compatible in certain south and central Florida soils.

Needle Cast of Pines

Needle cast of pines is a common fungus disease affecting all species of pines in Florida. It is easily recognized in the spring of each year as infected trees exhibit varying degrees of needle browning/reddening, typically beginning in the lower portion of the tree's crowns and confined to second-year needles (i.e., needles produced the previous growing season). Needles discolor from the tips inward and infected trees often appear as if they had been fire-scorched.

Needle cast infections are caused by a variety of fungi. In Florida, *Lophodermium* spp. are most commonly detected on infected foliage. Generally, needle cast infections are of no consequence to the infected trees. In extreme cases, however, infection may slow the growth of infected trees, and infections may warrant fungicidal control in specialty situations such as Christmas tree plantations where lush green foliage is essential or desired.

Nectria Canker of Hardwoods

Nectria cankers are not a major disease problem of hardwoods in Florida. However, they are frequently observed on various maples and oaks, and the fungus pathogen, *Nectria galligena*, has recently been found on eastern redbud (*Cercis canadensis*) and West Indies mahogany (*Swietenia mahagoni*). Typical nectria cankers are perennial in nature (i.e., the fungus is active in the host cambial tissues for several years) and frequently appear somewhat "target-like" due to the development of successive (annual) layers of callus tissue by the host tree at the margins of the enlarging canker face. Cankers are frequently associated with branch stubs on maples and oaks. The pathogen produces spores in minute, orange to red fruiting bodies (perithecia) formed in bark fissures or bark surfaces associated with cankered tissues.

Typical Nectria cankers have not been observed to date on eastern redbud of West Indies mahogany. On these species, *N. galligena* has been detected in association with burl-like galls and hypertrophied, roughened and fissured bark in branch axils, respectively. Experiments have demonstrated that the pathogen is capable of causing canker infections on both of these host species.

Hypoxylon Canker of Hardwoods

Fungi of the genus *Hypoxylon* are common and widespread on Florida hardwood tree species. These fungi are secondary, mildly aggressive pathogens at best, but they often cause considerable distress to tree lovers because of their high visibility on brownish, black, or silver-gray, crust-like fruiting bodies (stromata) they produce on trees which are dead and/or dying due to stress (esp. water stress) or injury. Stromata typically appear on the surface of the stem/branch wood as the bark of infected trees sloughs and falls away.

Sycamore Cankers and Leaf Scorch

The native range of sycamore (*Platanus occidentalis*) in Florida is limited to portions of the Apalachicola, Choctawhatchee, and Escambia river basins in Florida's western panhandle. Sycamore has, however, been extensively planted throughout the state for shade and ornamental purposes. In certain areas of the state sycamore has sustained serious damage due to infections by a variety of pathogenic organisms. Canker fungi, including *Botryosphaeria* spp., and a *Phomopsis* sp. have caused serious damage to and mortality of sycamores in more than one area. Canker infections are often water-stress related and are characterized by progressive branch mortality from the top of a tree downward as the infection progresses.

Another disease which has been confirmed on sycamore in Florida is leaf scorch caused by microorganisms referred to as fastidious xylem-inhabiting bacteria (FXIB; *Xylella fastidiosa*). These microorganisms are vectored (disseminated) by certain type of leafhoppers (insects of the order Homoptera). Once introduced into a susceptible host they proliferate and result in an occlusion ("plugging") of water conducting vessels. Leaves on infected trees dehydrate, exhibit marginal to complete "scorching" (i.e., red-brown discoloration) become crisp and curl up, generally beginning in the inside/lower crown and progressing outward and upward in contrast to the progressions of symptoms on cankered trees (above). Leaves on branch tips typically remain green and healthy appearing.

Eucalyptus Cankers

Although *Eucalyptus* spp. are not as popular in Florida as they once were, there are numerous group and individual plantings of these trees throughout much of southern Florida. In fact, several thousand acres of commercial forest eucalyptus plantations have been planted in the Glades and Highland County areas. A number of canker fungi are known to infect various *Eucalyptus* spp. in Florida, but little research has been conducted regarding their respective biologies, etc. Canker fungi documented on eucalyptus in Florida to date include *Botryosphaeria dothidea*, *Cryphonectria cubensis*, and apparently *C. gyrosa*. *C. cubensis* causes basal cankers on a number of *Eucalyptus* spp. In certain situations these cankers may have significant adverse effects on coppice (stump sprout) regeneration in commercial forest plantings. *C. gyrosa* is often detected in association with vertically fissured bark at the base of dead or declining trees and is recognized by the small (ca. 1-2 mm) orange, wart-like spore-producing structures (stromata) it produces in bark tissues and on bark surfaces. *C. cubensis* produces small, black, pear-shaped fruiting bodies (pycnidia and perithecia) beneath sloughing bark tissues associated with the basal cankers it incites.

Lethal Yellowing of Palms

Lethal yellowing of palms has, since first being detected in Key West in 1955, literally left a trail of death and destruction amid Florida's coconut palm (*Cocos nucifera*) population as it has progressed northward along the state's east and west coastlines. This disease is caused by a submicroscopic mycoplasma-like organism (MLO) which is apparently vectored by the leafhopper, *Myndus crudus* (of the insect order Homoptera). The MLO proliferates in the vascular tissues of infected palms

causing characteristic blackening and death of emerging flowers, yellowing of fronds, premature dropping ("shelling") of coconuts, and ultimately the death of its victim. Injection of susceptible palms (of which there are several species) with oxytetracycline antibiotics has been employed in Florida as part of a multi-faceted program to preserve valuable palms and retard the advance of the disease. However, the production and planting of generically resistant coconut palms (e.g., 'Maylayan Dwarf', and 'Maypan') and the use of alternative, non-susceptible palm species offers the most promise for dealing with the disease over the long run.

Root Rots of Oaks

The decline and mortality of oaks is a recurrent and continuing problem in many areas of Florida. The value of live and laurel oaks (*Quercus virginiana* and *Q. laurifolia*) as well as the other oak species as shade and ornamental trees statewide makes oak losses a serious problem. No single specific cause can be blamed for Florida's "oak decline" problems. Causes are multiple and usually vary from situation to situation, but root diseases are frequently involved, especially where the declining trees have suffered prior injury due to construction, agricultural practices, etc. Common root diseases of oaks in Florida include Ganoderma root rot (caused by *Ganoderma lucidum* and *G. curtsii*), mushroom root rot (caused by *Armillaria tabescens*), and root infections caused by the canker fungus *Endothia gyrosa* (Table 3). In some cases the roots and butts of mechanically damaged trees are colonized and decayed by various other basidiomycetous wood-destroying fungi. *Phytophthora cinnamomi*, an aggressive "water mold" fungus is frequently associated with moribund feeder roots of dead/dying oaks as well. Butt rots are common on old, overmature laurel and water oaks. Declining oaks are not uncommonly attacked by secondary pests such as certain wood-boring insects and *Hypoxylon* spp. (above).

Table 3. Fungi commonly associated with root and butt rots of oaks in Florida.

Ganoderma spp.:

The cause of **Ganoderma Root Rot**. Common on a variety of hardwoods, particularly oaks. Sporophores produced at various times, but commonly around May. Sporophores typically near base of diseased or dead trees, stalked or nonstalked and tough, usually with a yellow to red-brown, lacquered upper surface, white and porous beneath when fresh. Immature sporophores appear as white to yellow knobs.

Polyporus spp.:

The cause of various **Root and Butt Rots**. Common on several hardwoods, including oaks. Sporophores variously colored and shaped, porous on the undersurface, often attached as brackets to the base of diseased trees.

Armillaria tabescens (formerly *Clitocybe tabescens*):

The cause of **Mushroom Root Rot**. Common on a variety of oaks and other hardwoods, as well as conifers and palms. Sporophores produced at various times, but mostly in the fall. Sporophores fleshy and short-lived, light brown to tan in color with gills beneath, produced in clusters from a common base at or near diseases or dead trees. Characteristic mats of fungus tissue often produce beneath the bark of infected roots and tree bases, mats frequently perforated.

Endothia gyrosa:

More typically a **Branch or Twig Canker Fungus**. However, commonly observed on oak roots at soil surface when lawn mower of other damage is prevalent. Typically appears as clusters of small (about 1 mm) orange-red warts in or on bark tissues at or near wounded portions of roots.

Phytophthora Root Rot of Red Maple

An apparently rare, but interesting root disease of red maple (*Acer rubrum*) has been detected recently in Florida. To date the disease has been diagnosed on only four trees, one in Ft. Myers, one in the Orlando area, one in Ft. Lauderdale, and one in Naples. The significance of this disease is unknown, but observed infections appear to spread up infected trees very rapidly and infected trees are killed by the fungus. The fungus, *Phytophthora palmivora*, apparently infects roots of susceptible trees and rapidly grows up through the cambium, well into the stem and crown of infected trees. Infected stems exude amber-brown sap and infected bark stains a coffee colored brownish-black.

Stem Canker of 'Drake' Elm

Drake elm (*Ulmus parvifolia* 'Drake') is a popular ornamental species and is widely grown and sold in Florida. Problems with a serious and occasionally lethal cankering of the stems of these trees have repeatedly surfaced in Florida in recent years. Cankers appear on both nursery stock in ornamental nurseries and on trees in the landscape. They begin with the appearance of a distinct blistering and pealing of the smooth outer bark. In time, cambial growth of the host trees frequently produces pronounced callus folds at the margins of the necrotic cankered areas. Cankers may be small and discrete or they may be markedly elongated, sometimes encompassing most of all of the length of infected stems. Many cankers are apparently initiated near the groundline. Stem breakage at or near the loci of advanced cankers is common.

To date there is no consensus regarding a specific causal agent for these cankers. Numerous hypotheses have been presented, and some have been experimentally tested. None, however, has proven entirely satisfactory re explaining the canker phenomenon. Similarities between the appearance of these cankers and "sunburn" on branches of apple trees in the northeastern U.S., however, compel the author to draw some parallels here. Observations in Lakeland on drake elms continuously cankered along the main stem and primary (scaffold?) branches, entirely on

the upper surfaces (i.e., sun-exposed surfaces) of same, is supportive of such a parallel.

Mangrove Galls

Mangroves are among the most abundant and perhaps most important plant species growing along Florida's extensive coastline and associated estuaries. Diseases of mangroves have received very little study in Florida, and consequently little is known regarding mangrove pathology. However, some effort has been directed at elucidating the cause and biology of distinct globose to irregular galls (swellings) and dark, roughened bark occurring on stems, branches, and prop roots of red mangrove (*Rhizophora mangle*). Researchers have identified a fungus (*Cylindrocarpon didymum*) associated with these galls and have attributed the galls to pathogenic infection by this fungus. The galls are apparently not a major threat to red mangroves, although they may render infected stems vulnerable to wind breakage. A similar (if not identical) disease is reported to occur on *Rhizophora* spp. in West Africa.

Butt Rot of Palms

The fungus, *Ganoderma zonatum* (formerly, *Ganoderma sulcatum*), infects and kills many palms throughout Florida each year. Palms in ornamental settings, especially if they are grown in sties subject to prolonged periods of moisture retention from poor drainage, excessive shade, and/or irrigation sprinklers, are particularly vulnerable. The fungus typically produces, sessile, shelf- or bracket-like sporophores (conks) on the stems and bases of dead and dying palms. Appearance of conks on the stem is a sure sign of impending death for infected palms and controls *per se* are limited to prevention.

Plants as Tree Pathogens

Plants growing in or on trees are often distinctive and highly visible. To some, the presence of plants attaches to or hanging from the trunks and branches of yard trees is often disconcerting. In certain cases, concern may be justified, while in other there is little, if any, reason for alarm. Some higher plants actually attach themselves to and draw all or part of their sustenance from the host trees (**PARASITES**). Others simply hang down or grow on their hosts while manufacturing (producing carbohydrates via photosynthesis) or acquiring their nutritional requirements independently (**EPIPHYTES**). A third group of plants which often represents problems for trees consists of vines which root in the soil and manufacture their own food via photosynthesis, but climb on available trees (**CLIMBERS**). Parasitic plants are often harmful to their hosts, especially if present in abundance. Epiphytes, on the other hand, are rarely harmful. Climbing vines are usually harmless when small, but can, over time, develop into real problems as they grow around the trunks and throughout the crowns of trees. Any plant that develops to point of significantly shading the foliage of its host tree should be considered harmful.

Plants growing in or on trees in Florida some in varying sizes, shapes and

colors. The common **Mistletoe** is readily recognized in the winter on hardwoods which have lost their leaves by the globose (spherical) growth habit of the evergreen, leafy plants. Close inspection of this parasitic plant reveals typical attachments to host branches at the base of repeatedly branched, central stems. **Spanish Moss**, perhaps Florida's best known epiphyte, is recognized easily by the hanging or draped appearance of its gay-green foliage. **Ball Moss**, a bromiliad similar to spanish moss, occurs in ball-like clusters, as opposed to the hanging or shroud-like habit of the latter. **Other Bromiliads** are vase-like in appearance and resemble their well known cousin, the pineapple. Epiphytic **Lichens** typically appear as masses or patches of small gray-green, blue-green or reddish-green flakes or "bushes" along the branches of their hardwood hosts. **Root Parasites** vary from chlorophyllous (green, having chlorophyll) plants with brightly colored and distinctive, seasonal flowers (for example, senna seymeria on pines) to drab brown, achlorophyllous (not green, lacking chlorophyll) plants with inconspicuous foliage and flowers (for example, beechdrops on beech and squawroot on oaks). **Climbers**, of course, are simply vines of various descriptions.

Most plants growing in or on trees in Florida reproduce by seed. **Lichens and Resurrection Ferns** are exceptions, however, in that these plants reproduce by means of minute, wind-disseminated spores. Some lichens also spread by means of small vegetative fragments (flakes) which break off from parent plants and are disseminated by the splattering action of rain. **Mistletoe** is typically spread from tree to tree by birds that feed on its seed only to deposit them later through their excrement or by wiping the sticky seeds from their beaks onto host branches. The seed of **Bromeliads** (spanish moss, etc.) are spread though the air by the wind, and to some extent the splashing of rain. Seeds produced by **Climbers** (vines) and **Root Parasites** are spread by a variety of agents including wind, water, birds, and rodents.

Table 4. Some common types of higher plants growing in or on trees in Florida.

Type/Examples	Common Hosts	Control
PARASITES:		
Mistletoe *Phoradendrom serotinum* (Formerly *Phoradendron flavescens*)	**Pecans**: *Carya illinoensis* **Oaks**: *Quercus* spp. **Hickories**: *Carya* spp. **Other hardwoods**	If control is desired or considered expedient prune infected branches at least one foot below point of mistletoe attachment.
Woe Vine *Cassytha filiformis*	**Various trees**	No practical control. Roguing/destruction of parasitized trees.

ROOT PARASITES:		
Senna Seymeria *Serymeria cassioides*	**Pines**: *Pinus* spp.	Prescribed or controlled burns may be helpful in severely infected, young pine plantations. Fires should be timed after spring seed germination, but before flowers appear.
Squawroot or Cancer Root *Conopholis americana*	**Red Oaks**: *Quercus* spp.	No practical control.
Beechdrops *Epifagus polypodiodes*	**American Beech**: *Fagus grandifolia*	No practical control.
EPIPHYTES:		
Resurrection Fern *Polypodium polypodiodes*	Most trees. Often less common on pines due to the flaking or shedding nature of pine bark.	Control unnecessary in most situtions. If desired, mechanically remove plants by hand. Sprays such as Bordeaux mixture provide some control of bromeliads and lichens.
Bromeliads such as: Spanish Moss: *Tillandsia usneoides* Ball Moss: *Tillandsia recurvata* Cardinal Air Plant: *Tillandsia fasciculata*		
Lichens: "Fruiticose" or Branched or Bush-like *Usnea* spp. "Foliose" of Leaf-like *Parmelia* spp. "Crustose" of Crust-like *Pyrenula* spp.		

CLIMBERS:

Grapevines: *Vitus* spp. Ludzu: *Pueraria lobata* Wisteria: *Wisteria sinensis* Greenbriars: *Smilax* spp. Poison-ivy: *Rhus radicans* Virginia creeper: *Parthe-Nocissus quinquefolia* Trumpet creeper: *Campsis radicans* Carolina jessamine: *Gelsimium sempervirens* Japanese honeysuckle: *Lonicera japonica* Crossvine: *Bignonia capreolata*	Most trees. Climbers are not host specific.	Do not allow climbers to develop in highly valued ornamentals. Mechanically remove young vines taking care to pull roots where practicable to prevent regrowth. Cut older, established climbers near the ground and pull from trees following death and deterioration of the vines.

Control of Tree Diseases

Control of tree diseases is a complex matter. A wide variety of approaches to tree disease control are available and the selection of a particular control strategy or combination of strategies must be based on the particular circumstances at hand. Strategies that are effective and legal in one situation may be entirely ineffective in another situation, or perhaps even illegal (use of fungicides, etc.), or both. Intelligent disease control should be predicated on a thorough understanding of the particular disease problem and a careful integration of all appropriate control strategies. It should always be remembered, however, that **prevention is by far the most effective control for tree diseases.** Treatment of trees already infected with disease causing microorganisms is often futile. Many tree diseases can be prevented by 1) **proper tree/site selection during planting**, 2) **proper cultural practices**, and 3) **avoidance of injury and stress.** Tables 5 and 6 provide a framework within which control of tree disease and treatment of diseased trees may be considered.

Table 5. Major strategies for control of tree diseases.

Control Type	Description
Regulatory	Government inspections, certifications, quarantines, etc.
Silvicultural/Arboricultural	Proper site selection, cultural methods, etc.

Sanitation	Destruction of diseased material, clean-up of contaminated containers, benches, etc.
Biological	Suppression of pathogen activity via introduction of one or more beneficial organisms which parasitize, antagonize or otherwise inhibit the pathogen involved (or the promotion of such biological control organisms via appropriate modification of cultural practices, local environments, etc.).
Genetic	Breeding and utilization of genetically resistant varieties, etc.
Chemical	Use of specific sprays, fumigants, injections, etc.

Table 6. Basic treatments for diseases trees.

Disease Type	Treatments/Comments
Foliage Diseases (leafspots, blisters, needle cast, etc.)	a) 'control' is usually unnecessary except in special situations b) sanitation (clean up and destroy diseased leaves, potted trees, etc.) c) environmental modification (provide aeration, minimize water accumulation/ retention, etc.) d) appropriately registered fungicides
Stem/Branch Diseases	
1) Localized (gall, canker, etc.)	a) pruning/surgery b) sanitation c) minimize injury/stress d) 'good' arboriculture
2) Systemic (vascular wilt, etc.)	a) fertilization (demonstrated effective in certain cases for maples with *Verticillium* infections) b) fungicide injections(?)
Root Diseases (root and butt rots)	a) treatments generally ineffective, although metalaxyl fungicides may have some utility re control of *Phytophthora* or *Pythium* infections

Some Thoughts on Tree Injections

Injection of trees with various materials including mineral nutrients, insecticides, fungicides, and antibiotics has received a great deal of attention in arboricultural circles in recent years. Interest in tree injection has been heightened by, among other things, occasionally dramatic beneficial responses to certain types of injections, the ecological advantages of target-specific chemical application offered by injections as opposed to broadcast sprays, etc., the marketing proficiency of injection technology/product manufacturers, and the salability of "injection" as an arboricultural service. Like most other technological innovations, tree injection brings with it a variety of weaknesses as well as strengths. Understanding this reality provides a reasonable perspective within which tree injections may and should be included in the arboriculturalist's repertoire of tree maintenance/treatment strategies. Unfortunately, however, misinformation, unrealistic expectations, and overzealous "marketeering" all too often have and continue to upset this reasonable perspective. Although some tree injections are useful (beneficial) and appropriately prescribed, all injections should be applied with an adequate appreciation of factors such as those listed in Table 7.

Table 7. Some important factors to consider when considering or prescribing tree injections for control of tree diseases.

Drilling holes in trees is injurious to trees.

Single injections often yield only a temporary beneficial response, and single injections applied alone with no other "treatments" are rarely, if ever, effective - especially for disease control.

The cumulative effects (injuries) of repeated injections may be worse than the initial problem.

Injections of diseased trees for treatment of disease are rarely curative, although "therapeutic" injections may temporarily arrest symptom/disease development. Most injections for disease control are primarily effective as and should be applied for disease prevention.

Injections are useless if the problem (i.e., disease) is improperly diagnosed and/or the wrong treatment is applied.

unless injections are performed properly, they are of little or no benefit.

For certain diseases injections are simply ineffective.

Other treatments are often equally or more effective then injections

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